Atty. Docket No. PIA31069/ANS
Serial No: 10/751,184

## Remarks

Applicant and his undersigned representative thank Examiner Gravini for the helpful and courteous discussion held on August 10, 2005. The claims have been amended as suggested in the discussion to overcome the art of record, and issues relating to the priority application and copending Application No. 10/749,635 (the "'635 application") are further summarized and discussed below.

The present invention relates to a method for etching a metal layer having an antireflective coating (ARC) layer thereon, comprising a first dry cleaning process in an etching chamber with an oxide-based gas, a second dry cleaning process in the chamber with a gas mixture comprising $Cl_2$ and $CHF_3$, then etching the metal layer. The present method generally decreases microloading effects (e.g., etching a metal layer in a semiconductor device at a different rate closer to the edge of the wafer than in the center of the wafer; see, e.g., page 1, lines 5-9; page 3, lines 7-13; and page 5, line 19 through page 6, line 12 of the present specification).

## The Rejection of Claims 1-5, 7-12 and 16 under 35 U.S.C. § 102(e)

The rejection of Claims 1-5, 7-12 and 16 under 35 U.S.C. § 102(e) as being anticipated by Verhaverbeke et al. is respectfully traversed.

Verhaverbeke et al. discloses a single wafer wet/dry cleaning apparatus comprising a transfer chamber having a wafer handler contained therein, a first single wafer wet cleaning chamber directly coupled to the transfer chamber, and a first single wafer ashing chamber directly coupled to the transfer chamber (Abstract). With regard to etching a metal layer, Verhaverbeke et al. discloses a process tool or system 600 which can be used to etch features, such as metal or polysilicon lines, or openings in dielectric layers or silicon substrates and can be used to strip or clean the photoresist layer used to pattern the features. Etch/strip process tool 600 includes a single wafer wet cleaning module 200, an integrated particle monitor 300 and a

critical dimension (CD) measuring tool 700. A strip or dry clean module 400 can also be attached to chamber 610, if desired. Wet cleaning module 200, strip module 400, integrated particle monitor 300, and critical dimension measuring tool 700 are each connected to transfer chamber 610 through a separately closable and sealable opening, such as a slit valve (paragraph [0065]).

Verhaverbeke et al. also discloses the patterning of a conductive film or stack of conductive films into features in an integrated circuit. As shown in FIG. 10a, a wafer or substrate, such as wafer 1000, is provided to apparatus 600 in a FOUP 620. Wafer 1000 includes a blanket deposited conductive film 1002 formed across the surface of the wafer. The film 1002 can be a metal or metal alloy film, and may include an antireflective coating (ARC) 1005, such as titanium nitride (TiN). Formed on conductive film 1002 is a mask 1004, such as a well-known photoresist mask, which has a pattern defined therein. In order to process wafer 1000, the door to transfer chamber 610 is opened as is the connected door on FOUP 622, and wafer 1000 is removed from FOUP 622 and brought into atmospheric transfer chamber 610 by robot 612. Robot 612 then transfers the wafer into CD module 700. If the CD measurements are out of compliance, then wafer 1000 can be prepared for rework by removing wafer 1000 from CD module 700 and inserting it into strip chamber 400 whereby the photoresist mask 904 is stripped. The stripped wafer is then removed from strip module 400 and inserted it into wet clean chamber 200 where wafer 1000 is wet cleaned as described. Wafer 1000 can then be removed from clean module 200 and removed from system 600 where it is now ready for application of a new photoresist mask and patterning (paragraph [0094]).

Verhaverbeke et al. appears to be silent with regard to a method for etching a metal layer having an antireflective coating (ARC) layer thereon, comprising first and second dry cleaning processes in an etching chamber, the first with an oxide-based gas and the second with a gas mixture comprising $Cl_2$ and $CHF_3$. Consequently, this ground of rejection is unsustainable, and should be withdrawn.

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The Rejection of Claims 1-16 under 35 U.S.C. § 102(d)

The rejection of Claims 1-16 under 35 U.S.C. § 102(d) as being barred by Korean Patent Publication No. 2002-086042 ("KR '042") is respectfully traversed.

KR '042 is not Applicant's priority application. As evidenced by the attached pages obtained through the U.S. Patent and Trademark Office Patent Application Information Retrieval (PAIR) system, Applicant's undersigned representative filed a certified copy of Applicant's priority application (Korean Patent *Application* No. 10-2002-086802) on January 27, 2004. The priority Application No. 10-2002-086802 ends in the three digits "**802**," whereas KR '042 (which itself corresponds to Korean Patent *Application* No. 2001-0025683, filed on May 11, 2001) ends in the three digits "**042**". Thus, KR '042 is not Applicant's priority application.

Consequently, this ground of rejection is unsustainable, and should be withdrawn.

The Rejection of Claim 6 under 35 U.S.C. § 103(a)

The rejection of Claim 6 under 35 U.S.C. § 103(a) as being unpatentable over Verhaverbeke et al. is respectfully traversed.

Claim 6 depends from claim 1. Therefore, claim 6 includes the same limitations as claim 1 above. As explained above, Verhaverbeke et al. do not disclose or suggest a method for etching a metal layer having an antireflective coating (ARC) layer thereon, comprising first and second dry cleaning processes in an etching chamber, the first with an oxide-based gas and the second with a gas mixture comprising $Cl_2$ and $CHF_3$. Thus, for essentially the same reasons as for claim 1, claim 3 is patentable over Verhaverbeke et al.

Consequently, this ground of rejection is unsustainable, and should be withdrawn.

The Rejection of Claims 13-15 under 35 U.S.C. § 103(a)

The rejection of Claims 13-15 under 35 U.S.C. § 103(a) as being unpatentable over Verhaverbeke et al. in view of Zhao et al. is respectfully traversed.

Claims 13-15 depend from claim 1. Therefore, claims 13-15 include the same limitations as claim 1 above. As explained above, Verhaverbeke et al. do not disclose or suggest. As will be explained below, Zhao et al. fails to cure these deficiencies of Verhaverbeke et al. Thus, for essentially the same reasons as for claim 1, claims 13-15 are patentable over Verhaverbeke et al. in view of Zhao et al.

Zhao et al. disclose systems, methods and apparatus for depositing titanium films at rates up to 200 Å/minute on semiconductor substrates from a titanium tetrachloride source (Abstract, ll. 1-4). Zhao et al. further disclose forming titanium-containing films such as titanium, titanium nitride, and titanium disilicide as patterned conductive layers, plugs between conductive layers, diffusion barrier layers, adhesion layers, and as a precursor layer to silicide formation, along with depositing other types of metal films, etc. (col. 1, ll. 37-47), and that titanium can be used to improve the adhesion between two layers, such as between silicon and aluminum (col. 2, ll. 41-43). However, the undersigned was not able to find any disclosure regarding aluminum and/or silicon byproducts *eliminated* by any process disclosed by Zhao et al. from col. 1, l. 34 through col. 2, l. 54.

Zhao et al. teach that chemical species, such as chlorine, used in dry clean processes attack the aluminum heaters used in conventional PECVD systems (col. 3, ll. 7-63). Thus, Zhao et al. arguably teach away from dry cleaning processes that include $Cl_2$ gas, although Zhao et al. actually disclose a specific process for dry cleaning a chamber with $Cl_2$ gas (see col. 38, ll. 14-57).

For example, and also referring to FIG. 19, if a certain number of wafers have been processed, the chamber is due for a dry clean (step 1024). First, the heater is moved further away from the showerhead (step 1025), and maintained at the processing temperature. The chamber is purged with a purge gas, such as argon, at a pressure higher than the process pressure,

preferably about 15 torr in a specific embodiment (step 1026), and then pumped down to about 0.6 torr (step 1027). Chlorine ($Cl_2$) gas is then flowed into the chamber at a rate of about 200 sccm, in addition to argon gas (step 1028), which will assist with plasma formation. Next, a plasma is struck at a power of about 400 watts (step 1029). This condition is held for about 80 seconds, during which time the chlorine species react with unwanted deposits and argon plasma species physically bombard deposits to etch these deposits from the chamber components. By moving the heater away from the showerhead, the conditions given above ensure sufficient cleaning of all chamber components without overetching any of those components, especially the showerhead. After the plasma clean, the chlorine gas is turned off and the plasma power is reduced to about 50 watts to perform a plasma purge for about 5 seconds (step 1030). The temperature is then preset to about 635 °C. (step 1031) in preparation to process wafers by loading the next wafer into the chamber (step 1032), and the chamber is pumped out for about 15 seconds.

Thus, Zhao et al. do not appear to teach or suggest a process for etching a metal layer having an oxide-based antireflective coating (ARC) layer thereon, comprising a first dry cleaning process in an etching chamber with an oxide-based gas, and a second dry cleaning process in the chamber with a gas mixture comprising $Cl_2$ and $CHF_3$ (the present claim 1), much less eliminating aluminum- and silicon-containing byproducts (the present claim 13). As a result, Zhao et al. fails to cure the salient deficiencies of Verhaverbeke et al. with regard to the present claims.

Since neither reference discloses or suggests a method for etching a metal layer comprising first and second dry cleaning processes in an etching chamber, the first with an oxide-based gas and the second with a gas mixture comprising $Cl_2$ and $CHF_3$, as recited in amended claim 1 above, no combination of Verhaverbeke et al. and Zhao et al. can disclose or suggest the presently claimed invention. Consequently, this ground of rejection is unsustainable, and should be withdrawn.

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The Rejection of Claims 1-16 for Obviousness-Type Double Patenting

The rejection of claims 1-16 under the judicially-created doctrine of obviousness-type double patenting in view of claims 9-15 of co-pending and commonly owned Application No. 10/749,635 (the "'635 application") is respectfully traversed.

The claims of the present application are directed to a method, while claims 9-15 of the '635 application are directed to an apparatus. Historically, the U.S. Patent Office has required restriction between groups of claims directed to these different statutory categories of subject matter (see, e.g., MPEP § 806.05(c)). Where inventions are independent, as are the present claims and claims 9-15 in the '635 application, then restriction is ordinarily proper (see MPEP § 806). When restriction is required between a process and an apparatus for its practice, then the U.S. Patent Office concludes that the different groups of claims are patentably distinct (see MPEP §§ 802.01 and 806.05(c)).

Applicant's undersigned representative does not dispute that the USPTO commonly issues patents with claims to both method and apparatus. In fact, Applicant's undersigned representative applauds the USPTO for every time it has done so. However, the point in the Amendment filed November 18, 2004, was not necessarily one of generality, but rather, one of a specific case.

However, regardless of whether restriction was actually required in the '635 application or not, other than reciting a chamber and $Cl_2$ and $CHF_3$ gases, claims 9-15 of the '635 application have very little in common with the present claims 1-16. The present claim 1 recites etching a metal layer; claims 9-15 of the '635 application do not. The present claim 1 recites first and second dry cleaning processes; claims 9-15 of the '635 application do not recite any dry cleaning process. The present claim 1 recites a first dry cleaning process with an oxide-based gas; claims 9-15 of the '635 application do not mention an oxide-based gas. The present claim 1 recites a dry cleaning process with a gas mixture comprising $Cl_2$ and $CHF_3$; claims 9-15 of the '635 application do not.

On the other hand, claim 9 of the '635 application relates to a plasma ignition method; the present claims 1-16 do not specify anything relating to plasma ignition. Claim 9 of the '635 application sets a predetermined flow rate of Ar gas into the chamber; the present claims 1-16 do not. Claim 9 of the '635 application completes the supply of $Cl_2$ gas prior to igniting plasma; the present claims 1-16 do not.

Consequently, the differences between claims 1-16 of the present application and claims 9-15 of the '635 application are numerous and technically significant. One might even argue that there are more technical differences between the present claims 1-16 and claims 9-15 of the '635 application than there are similarities among them. As a result, this ground of rejection is unsustainable, and should be withdrawn.

Applicant's Claim to Priority

As stated above and evidenced by the attached pages obtained through the U.S. Patent and Trademark Office PAIR system, Applicant's undersigned representative filed a certified copy of Applicant's priority application (Korean Patent Application No. 10-2002-086802) on January 27, 2004. The U.S. Patent and Trademark Office date-stamped the papers accompanying the certified copy of Applicant's priority application on January 30, 2004. Applicant's representatives have therefore met the requirements for claiming priority to Korean Patent Application No. 10-2002-086802. Applicant's undersigned representative respectfully requests acknowledgement on the record that a certified copy of Applicant's priority application has been filed and that Applicant has met the requirements for claiming priority to Korean Patent Application No. 10-2002-086802.

The Claim Objection(s)

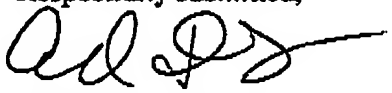
The objection to claim 11 has been obviated by appropriate amendment.

## Conclusions

In view of the above amendments and remarks, all grounds for rejection are overcome, and the application is in condition for allowance. Early notice to that effect is earnestly requested.

If it is deemed helpful or beneficial to the efficient prosecution of the present application, the Examiner is invited to contact Applicant's undersigned representative by telephone.

Respectfully submitted,



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